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ABSTRACT

This report provides an overview of multimedia access barriers and solutions for people with sensory disabilities, including recommended public policy interventions. A letter of transmittal to the President and both houses of Congress precedes the main body of the report. An executive summary groups recommendations under the following categories: establishment and tasks of a National Advisory Task Force on Multimedia Access; legislative/regulatory policies (at both federal and state levels); and research, education, and collaboration. The report's main body is divided into five sections which address: (1) use and importance of multimedia; (2) barriers to accessing multimedia; (3) solutions for making multimedia products accessible; (4) voluntary efforts to improve access to multimedia; and (5) recommendations for further action. Seven appendices provide information on a framework of multimedia categories; statistics on the number of people who are visually or hearing impaired in the United States; results of a survey of educators of people with visual impairments working with multimedia products; results of a questionnaire for educators of people who are blind or visually impaired; questions for educators and media specialists working with people with hearing impairments; a listing of current multimedia projects focusing on accessibility; and the mission statement of the National Council on Disability. A glossary is included. (Contains 90 references.) (DB)

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ACCESS TO MULTIMEDIA TECHNOLOGY BY PEOPLE WITH SENSORY DISABILITIES

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National Council on Disability

March 13, 1998

EC 307001

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**Access to Multimedia Technology
by People with Sensory Disabilities**

This report is also available in braille and large print and on diskette and audiocassette.

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NATIONAL COUNCIL ON DISABILITY

An independent federal agency working with the President and Congress to increase the inclusion, independence, and empowerment of all Americans with disabilities.

LETTER OF TRANSMITTAL

March 13, 1998

The President
The White House
Washington, DC 20500

Dear Mr. President:

On behalf of the National Council on Disability (NCD), I am pleased to submit a report entitled *Access to Multimedia Technology by People with Sensory Disabilities*. The report was developed with the advice of NCD's Tech Watch Task Force, a group of experts in technology and disability from around the country.

The rapid advances in technical capability and affordability are exciting. For America's 54 million people with disabilities, however, such technological developments are a double-edged sword that can release abundant opportunities or sever essential connections.

On the one hand, they can be revolutionary in their ability to empower people with seeing, hearing, manual, or cognitive impairments through alternative means of input and output to typical screens and keyboards. This is true because digital information generally is not inherently visual, auditory, or tactile. Rather, it can be expressed in any of those forms with appropriate programming. This allows previously inaccessible tasks to become possible and practical for individuals with disabilities, for example, a blind person using a CD-ROM-based encyclopedia on a computer equipped with synthetic speech output.

On the other hand, technological developments can present serious and sometimes insurmountable obstacles when principles of universal design are not practiced in their deployment. A distance learning course broadcast over the Internet, for example, is inaccessible to a deaf person if a text transcript is not also available.

This NCD report provides an overview of multimedia access barriers and solutions, including public policy interventions that we recommend as part of an overall strategy to make the electronic bridge to the 21st century available to all Americans. Thank you for the opportunity to play the independent role that our mission requires and to offer an assessment of progress and prospects in this area. NCD stands ready to work with you and stakeholders outside the government to see that the agenda set out in the attached report is implemented.

Sincerely,

Marca Bristo
Chairperson

(The same letter of transmittal was sent to the President Pro Tempore of the U.S. Senate and the Speaker of the U.S. House of Representatives.)

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CONTENTS

PREFACE xi

EXECUTIVE SUMMARY 1

USE AND IMPORTANCE OF MULTIMEDIA 11
- Definition of Multimedia 11
- Use of Multimedia in the Classroom 12
- Benefits of Multimedia in Education 13
- Use of Multimedia in the Workplace 14
- Benefits of Multimedia in the Workplace 15
- Importance of Multimedia Access for People with Disabilities 15

BARRIERS TO ACCESSING MULTIMEDIA 17
- Knowledge and Awareness 17
- Financial Barriers 19
- Access Barriers for People Who Are Blind or Visually Impaired 19
- Access Barriers for People Who Are Deaf or Hard of Hearing 21
- Access Barriers for People Who Are Deaf-Blind 23

SOLUTIONS FOR MAKING MULTIMEDIA PRODUCTS ACCESSIBLE 25
- Improving Access for People Who Are Blind or Visually Impaired 25
- Video Description for Visual Images 27
- Improving Access for People Who Are Deaf or Hard of Hearing 29
  - Captioning for Auditory Access 29
  - Speech Recognition 30

VOLUNTARY EFFORTS TO IMPROVE ACCESS TO MULTIMEDIA 31
- Access Guidelines 31

Company-Led Efforts 31
Industry-Led Efforts 34
Web Access Initiative 34
Advanced Television 35
Association to Promote Access Engineering 36
Information Infrastructure Standards Development 37

RECOMMENDATIONS FOR FURTHER ACTION 39
National Advisory Task Force on Multimedia Access 39
Legislative/Regulatory Policies 40
Government Procurement of Accessible Information Technology 40
Implementation of the Telecommunications Act 41
Copyright Reform 41
Incentives 42
PCTV Accessibility 42
State Action 43
Research, Education, and Collaboration 43

APPENDIX A: FRAMEWORK OF MULTIMEDIA CATEGORIES 47

APPENDIX B: NUMBERS OF PEOPLE WHO ARE BLIND OR VISUALLY IMPAIRED AND PEOPLE WHO ARE DEAF OR HARD OF HEARING IN THE UNITED STATES 51
Number of Persons in the United States Who Are Blind or Visually Impaired 51
Number of Persons in the United States Who Are Deaf or Hard of Hearing 52
Use of Computers and the Internet by People with Disabilities 52

APPENDIX C: SURVEY OF EDUCATORS OF BLIND OR VISUALLY IMPAIRED PERSONS WORKING WITH MULTIMEDIA PRODUCTS 55

APPENDIX D: RESULTS OF QUESTIONNAIRE FOR EDUCATORS OF PEOPLE WHO ARE BLIND OR VISUALLY IMPAIRED 59

APPENDIX E: QUESTIONS FOR EDUCATORS AND MEDIA SPECIALISTS OF PERSONS WHO ARE DEAF OR HARD OF HEARING 63

APPENDIX F: CURRENT MULTIMEDIA PROJECTS FOCUSING ON ACCESSIBILITY 65
Education 65
General 66
Internet 66
Kiosks 67
Software 68

APPENDIX G: MISSION OF THE NATIONAL COUNCIL ON DISABILITY 71
Overview and Purpose 71
Specific Duties 71
International 73
Consumers Served and Current Activities 73
Statutory History 74

REFERENCES 75

GLOSSARY 85

PREFACE

In August 1994, members of the National Council on Disability (NCD) began meeting with representatives of the computer industry to discuss the accessibility of graphically based software for people with disabilities, particularly people with severe visual impairments. To obtain ongoing information and advice about technology-related issues, NCD then established Tech Watch, a community-based, cross-disability task force. The 12-member task force advises NCD on issues concerning access to emerging technologies and helps monitor compliance with relevant laws.

This report was commissioned by NCD on the advice of Tech Watch. It is an overview of computerized multimedia technology, barriers to access for people with disabilities, and progress to date on addressing these issues. The report concludes with recommendations to policy makers and industry officials to solve problems raised in the report.

EXECUTIVE SUMMARY

This report by the National Council on Disability (NCD), an independent federal agency, focuses on the barriers to use of computerized multimedia technology by a significant segment of the disability community—people who have visual or hearing impairments—and recommends actions that would reduce or eliminate those barriers.

Advances in computer and telecommunications technology have made it possible to combine high-quality computerized video, audio, text, and images into attractive and compelling interactive multimedia presentations. As this new information technology increasingly renders the sounds, images, and textures of the real world in a virtual environment, people with visual or hearing disabilities face a troubling, uncertain future in which opportunities for employment, education, and recreation may be greatly enhanced or diminished as a direct result of new technology.

Publishers, schools at all levels, employers, and a host of cultural and civic-oriented institutions are grappling with multimedia technology. If a commitment to accessibility for all individuals is not ensured now, individuals with disabilities, particularly those with sensory disabilities, will suffer the loss of educational opportunities and employment options. On the other hand, a commitment by the information technology industry to develop and support multimedia products that are accessible to and usable by people with disabilities, and a commitment by government to purchase only accessible products, will give persons with disabilities heretofore-unrivaled opportunities to learn and contribute to society.

In an attempt to educate policy makers, manufacturers, and consumers about these issues, NCD, through its Tech Watch task force, commissioned a study on multimedia access for people with visual and hearing impairments. The research was conducted by the American Foundation for the Blind (AFB) and the National Association of the Deaf (NAD).

People with sensory disabilities are especially concerned about access to computerized multimedia programs because multimedia presentations rely on highly dynamic visual and audio formats to present information to the user. Multimedia developers expect the end users of a program to access both the audio and the visual information. However, because information presented in each medium conveys only part of the message, these presentations are not fully accessible to blind or visually impaired people or to people who are deaf or hard of hearing. The highly dynamic nature of computerized multimedia further magnifies the access problems.

The most significant barriers preventing people with sensory disabilities from achieving full and equal access to multimedia products are technological challenges, lack of knowledge and awareness concerning access issues, and the costs involved in developing access solutions. In some ways, the access barriers created by interactive multimedia technologies are not new. For example, people with severe visual impairments have generally found it difficult to use or understand fully visual images such as charts, photographs, and video. However, techniques have been developed to facilitate the interpretation of these visual images through text or verbal descriptions. Individuals who are deaf or hard of hearing are not able to use aural output such as beeps, speech, or music. However, closed or open captioning can provide access to aural output.

Similarly, the use of computers to create multimedia information has both augmented and diminished access barriers. For example, mouse movements or clicks often do not have keyboard equivalents, so visually impaired people are unable to use particular features. The use of bit-mapped text creates a barrier because it cannot be read by screen readers. Furthermore, font sizes and background colors built into computer software may make it unusable by people with low vision. On the other hand, designers of computer programs and World Wide Web pages are able to enhance access by providing keyboard alternatives for mouse commands and text descriptions of images and visual tools and by providing capabilities for enlarging text and for alternative colors and contrasts.

Unfortunately, the current state of multimedia access for people with sensory disabilities is bleak. There is essentially no multimedia product available that has been shown to be fully accessible to individuals who are blind, and very few multimedia products that are accessible to deaf or hard-of-hearing people. While the outlook for access to multimedia for persons with low vision may be slightly better, there is still cause for concern. Children and adults with low vision have been able to use some multimedia products, but additional work is needed to achieve full access. With respect to individuals who are deaf or hard of hearing, there is a general misconception that most media are currently captioned. The statistics provided in this report clearly show that very little of the content is captioned or made visually accessible in other ways. The limited amount of captioned educational material is especially worrisome.

Some major producers of multimedia applications have begun efforts to improve access to this technology. These are important first steps, but it is difficult to be optimistic about the speed at which such access will be attained based on the history of access to other forms of media and information technology—for example, the telephone, television/video, and the personal computer. It took almost 90 years after the invention of the telephone to provide deaf people with a means of access. Closed captioning of television was not initiated until 1980, and the vast majority of cable programming remains inaccessible. People who are blind or visually impaired must purchase add-on software and hardware to make personal computers accessible, and the most common operating system and many popular software applications are still difficult or impossible for these individuals to use.

Despite the current lack of accessible multimedia products and the troubling history of unequal access to information technology, there is room for guarded optimism. The methods by which individuals with disabilities can handle the basic operation of multimedia products—launch the program, select topics of interest, peruse material, terminate the session, and shut the system down—are now relatively well understood, though not standardized in implementation. A few notable mainstream computer companies and multimedia publishers are working on access issues. Researchers are attempting to develop accessible demonstration products. The World

Wide Web Consortium is working on access issues. Recent legislation has included accessibility language. Persons with disabilities are becoming more active in demanding access to technology. Indeed, many of the gains made thus far, however slight, can be credited to the power of consumer activism.

Access to multimedia is just one of many difficult challenges faced by technology users with disabilities, especially those who are blind, visually impaired, deaf, or hard of hearing. Few would suggest that the problems surrounding access to productivity tools such as word processors and spreadsheet programs have been solved. Even productivity tools that are voice-based (Internet phone and voice/speech recognition software) are generally inaccessible to deaf or hard-of-hearing users. The issues surrounding multimedia access must be integrated into the larger technology access picture. Multimedia content and delivery mechanisms are changing every day. A coordinated, cooperative effort is needed to ensure equality of access to this critical information technology. According to experts, the multimedia access challenges are not insurmountable. There is widespread agreement among those interviewed for this report that a lack of awareness of accessibility issues within the multimedia industry is the most significant factor limiting the development of accessible products.

NCD recommends the following actions to address multimedia access problems:

National Advisory Task Force on Multimedia Access

Based on the experience of the Texas Education Agency Task Force and the work of the Access Board's Telecommunications Access Advisory Committee, *a national advisory task force comprising representatives of industry, government, and the disability community should be convened to work toward an agreement on accessibility guidelines for multimedia technology.* The U.S. Department of Education may be in the best position to convene such a task force, because of the extensive use of multimedia in educational materials. Alternatively, the Access Board may be an appropriate entity to carry out such an activity, drawing upon work it has done

developing accessibility guidelines under Section 255 of the Telecommunications Act and (potentially) Section 508 of the Rehabilitation Act.

Some of the issues to be considered by such a national task force would include

- organizational processes to ensure consideration of accessibility (universal design) at all levels of product development and delivery;
- built-in access versus access via assistive technology such as screen readers and specialized input devices;
- industry-based or government-established standards versus voluntary guidelines;
- techniques for accessible input, output, and controls;
- methods to provide access to online help and product documentation; and
- methods to ensure customer support for disability access.

Legislative/Regulatory Policies

Congress and the administration should develop and implement legislative/regulatory policies to improve access to multimedia. For example, Section 508 of the Rehabilitation Act should be strengthened to promote access through government procurement of accessible information technology, exemptions from copyright restrictions to add accessibility through captions or video description, and tax credits or other financial incentives to support and promote the development of accessible multimedia technology.

Universal design concepts should be included in industry standards and guidelines for multimedia products. Technology industries are changing at a revolutionary pace. It is important that access issues be incorporated into new standards as early as possible if universal access is to become the rule rather than the exception. The Access Board's Telecommunications Act Accessibility Guidelines and the ongoing efforts of the World Wide Web Access Initiative provide encouraging examples of efforts to improve access to information technology. Multimedia-related standard-setting activities should be expanded to stimulate accessibility.

Government Procurement of Accessible Information Technology

Section 508 of the Rehabilitation Act requires federal agencies to comply with accessibility guidelines in the procurement of information technology. Enforcement of this law has proven inadequate, and many federal agencies purchase information technology that does not comply. Recently, amendments have been introduced in Congress to increase compliance with Section 508. For example, H.R. 1255, the Federal Electronic and Information Technology Accessibility Compliance Act of 1997, would require federal agencies to certify compliance annually, with oversight by the Office of Management and Budget. A companion bill has been introduced in the Senate. Efforts are also under way in the Senate to expand the scope and enforcement of Section 508 by assigning authority to the Access Board for regulations. The as-yet-unrealized intent of Section 508 has been to take advantage of the purchasing power of the Federal Government to create a market-based incentive for the production of accessible technologies and to ensure that they are usable by the 145,000 federal employees with disabilities.

Implementation of the Telecommunications Act

The legislative history of the Telecommunications Act of 1996 clearly shows that Congress intended the Federal Communications Commission (FCC) to regulate Section 255, Access by Persons with Disabilities. At the time of this publication, however, the FCC has not issued or even proposed such regulations. The unfortunate result is that new telecommunications

technologies and services, many of which are multimedia in nature, have been emerging each week without significant attention to universal design. The FCC must fully and speedily exercise its authority in this area to prevent unnecessary barriers to people with disabilities on the burgeoning information superhighway.

Copyright Reform

In 1996, Congress enacted legislation that eliminated the need to obtain the permission of publishers or copyright owners if an authorized entity wishes to reproduce or distribute a non-dramatic literary work in a specialized format for the exclusive use of blind persons or others with physical disabilities. The law defines authorized entities as nonprofit organizations or governmental agencies whose primary mission is to provide specialized services related to the training, education, adaptive reading, or information access needs of blind or other persons with disabilities. "Specialized formats" specifically include braille, audio, or digital text exclusively for use by blind or other persons with disabilities. "Blind or other persons with disabilities" means individuals who are eligible to receive specialized library services under definitions used by the National Library Service for the Blind and Physically Handicapped of the Library of Congress.

To date, no similar exemption from the copyright requirements exists for adding captioning or video description. Accordingly, it remains extremely burdensome to add captions or video description to copyrighted works, including videotapes and computer media, needed for instructional programming. Often, obtaining such permission can take upwards of six months, eliminating entirely the benefits of such materials for educators and students during a given semester. Legislation granting an exemption from copyright restrictions in order to reproduce such materials for the purpose of adding accessibility through captions or video description may be a useful step.

Incentives

Tax credits or other financial incentives could be crafted to support and promote the development of accessible multimedia technology, especially technology designed for employment or education. For example, the R&D Tax Credit was originally signed into law in 1981 as part of the Economic Recovery Tax Act (ERTA, P.L. 97–34). Corporations received a tax credit ranging from 1.65 percent to 20 percent for qualified R&D expenditures (QREs) that exceeded a certain fixed base amount. QREs had to be technological in nature and relate to the development of new or improved business products. This credit expired on May 31, 1997. Industry-supported efforts are under way to make the credit permanent. To the extent that incentives are continued or expanded, companies receiving incentives must be held accountable for their disability access obligations, including those under the Americans with Disabilities Act and the Telecommunications Act.

PCTV Accessibility

Many personal computers now have television circuitry that enables the computer to receive and display television signals. In March 1995, the FCC issued a ruling requiring computer systems that have the capability of receiving television signals and are sold with monitors that have a viewable picture size of 13 inches or larger to have built-in circuitry to decode and display closed captions. The FCC has based its ruling on the requirements of the Television Decoder Circuitry Act of 1990. The FCC's ruling exempted (1) computers that are sold without monitors but that have television reception capability and (2) separate plug-in circuit boards that can be used to add television reception capability to an existing personal computer. In December 1995, several consumer organizations representing deaf and hard-of-hearing individuals filed a petition for rulemaking requesting that the FCC require all computer components with television reception capability—whether or not such components are sold with a monitor—to be equipped with circuitry capable of decoding closed captions. This petition is now pending in the FCC's Office of Engineering and Technology.

State Action

Texas has taken a leadership role in analyzing and attempting to remove the access barriers posed by multimedia-based educational material. Texas was an early adopter of legislation designed to advance the availability of braille textbooks, including a requirement that publishers provide electronic versions of textbooks for braille production. Subsequent concerns about access to multimedia textbooks led to the Texas Education Agency's convening a task force to address access to multimedia material. On June 20, 1997, Texas governor George W. Bush signed Senate Bill 294, which calls for a study of the costs and benefits of using computer networks in Texas schools and creates a subcommittee to "investigate the feasibility and cost-effectiveness of developing electronic textbooks that may be used by students who are blind or have other disabilities." It is conceivable that the state will eventually require electronic textbooks to be accessible.

Research, Education, and Collaboration

Government agencies, private corporations, and foundations should conduct research on information technology access issues and the development of solutions. People involved in all aspects of the development of multimedia and other information technology should be educated about access issues.

Support is needed for research examining the technological and social issues surrounding access to multimedia and other information technology by persons with disabilities and the benefits of such access to individuals who are not considered disabled. In particular, research is needed on ways to make visual and aural information accessible to individuals with sensory disabilities.

Various government agencies fund research activities related to information technology and disability access. Principal among these agencies are the National Science Foundation, the Department of Commerce (National Telecommunications and Information Administration and

National Institute on Standards and Technology), and the Department of Education (National Institute on Disability and Rehabilitation Research). These agencies should be encouraged to fund further research into methods that enhance access to information technology for people with disabilities.

Mainstream technology and multimedia developers, producers of assistive technology, disability organizations, and research institutions should strengthen partnerships aimed at developing access and usability solutions. Use of multimedia products and other information technology by persons with disabilities is not well documented or understood. Mainstream developers who now rarely include persons with disabilities in marketing or usability surveys must do so. Furthermore, efforts to improve access and usability through assistive technology should be improved. In addition, though experts differ on the extent to which multimedia products will ever be accessible "out of the box" (built-in access does not appear imminent), efforts to improve the accessibility of mainstream products must be greatly expanded.

The development, sale, and use of information technology involves many people—educators, content providers, programmers, marketers, engineers, end users, and so on. If equal access to multimedia for people with disabilities is to become a reality, knowledge and awareness will have to be developed across all areas. Innovative methods to instruct those currently involved in the information technology and multimedia industry about access issues and solutions must be developed. The training and information dissemination efforts now being undertaken by the Association of Access Engineering Specialists provide a good example of such innovation. Enlisting the support and interest of university faculty and other experts across many disciplines—from computer science to publishing to education—is also important.

USE AND IMPORTANCE OF MULTIMEDIA

During the 1990s, multimedia technology has been a dominant focus of the computer industry. In its many forms, multimedia offers exciting possibilities for education and entertainment. And of all the media types—text, image, audio, video, and animation—video continues to dominate the public attention. In the past, computer-based multimedia relied on external laser disc players for the video source. The focus has shifted to video delivered on CD-ROM and, more recently, to digital video disc (DVD) and the World Wide Web.

Definition of Multimedia

Definitions of the term "multimedia" vary widely and include the following:

- "The use of more than one medium in a program or system such as the use of audio, video, graphics, animation and computer data used together for a program.... Multimedia means the joining of any two or more of these" (Santa Cruz Technology Alliance 1997),

- "Delivery of information, usually via a personal computer, that combines different content formats (text, graphics, audio, still images, animation, motion video, etc.) and/or storage media (magnetic disk, optical disc, video/audio tape, RAM)" (Interactive Multimedia Organization 1996),

- "A mix of sight and sound" (Bolnick 1997),

For this paper, because we are focusing on issues related to those who have hearing or visual disabilities, we have chosen to define multimedia as *technology that has the potential to be interactive and that includes both aural and visual elements*. See appendix A for an organizing framework we developed as we attempted to circumscribe our working definition of multimedia.

Use of Multimedia in the Classroom

The use of multimedia in schools is still at an early stage but is continuing to grow rapidly. In 1995, more than half the nation's schools lacked the electrical outlets to handle their technological needs, and only 9 percent of classrooms had dial-out telephone lines (MSNBC 1997). According to a 1996 report of the U.S. Department of Education (1996a), only 4 percent of schools had enough computers to allow regular use, and only 9 percent of classrooms nationwide had access to the Internet. A study by Quality Education Data (1996) showed that 83 percent of school districts planned to increase their multimedia computer purchases during the 1996–97 school year at a projected cost of 4.1 billion dollars. Currently 46 percent of all U.S. schools have connections to the Web, with an additional 21 percent predicting connection by 1998 (http://www.queddata.com).

The goals of President Clinton's and Vice President Gore's Technology Literacy Challenge include having a modern multimedia computer in every classroom and having every classroom connected to the information superhighway (U.S. Department of Education 1996a). Half the K–12 teachers in a recent survey said that students in their classroom are using a computer 10 or more hours per week (Consumer Electronics Manufacturers Association [CEMA] 1997).

According to the Corporation for Public Broadcasting/WGBH National Center for Accessible Media (NCAM), CD-ROMs are used more than any other type of multimedia in the classroom, and their use will increase, particularly for the teaching of science. Currently, CD-ROMs are being used by more than 18,000 science teachers in the United States (NCAM 1997a). The number of K–12 schools in the United States with CD-ROM drives increased from 13 percent in 1992 to 48 percent in 1995 (Apple Computer 1995). *The Chronicle of Higher Education* reports that 76 percent of college and university classrooms are equipped for multimedia (Apple Computer 1995).

Distance learning is also on the rise. Historically, distance learning meant broadcasting a lecture, usually on video or audio, to distant locations (Hall 1997). Distance learning, when conducted live, can now be interactive. Desktop video conferencing occurs in real time and may include "white board areas" where participants can communicate visually with each other through writing or drawing. Distance learning has become widespread because of certain advantages; including allowing students to take various classes that are not offered at their home school.

Benefits of Multimedia in Education

A report on technology use in education states that it can provide the following benefits:

- enhance students' achievement;
- help students master skills required for the workforce;
- serve as a motivational tool, improving attitudes toward learning, confidence, and self-esteem;
- enhance ability to remember and understand material;
- enhance organizational and problem-solving skills;
- help students become independent learners and self-starters;
- increase family involvement in children's education; and
- improve skills and knowledge of teachers (U.S. Department of Education 1996b).

Studies have found that students using technology have a distinct advantage over similar students who are not using technology. For example, it has been found that students perform much better than their peers on basic skills tests if their classes use computer-assisted instruction (U.S. Department of Education 1996b). A study by the Consumer Electronics Manufacturers Association (CEMA 1997) showed that 96 percent of teachers believe that computers are effective teaching tools and that children enjoy working with computers and their grades tend to improve when using this medium. FIND/SVP reports that children in households with personal

computers watch less television because they are using the PC; this finding is even stronger for households that have PCs with multimedia capability (Apple Computer 1995).

Use of Multimedia in the Workplace

The use of computer technology in the workplace is also increasing rapidly. In a 1996 survey of the American Society for Training and Development (ASTD), 73 percent of training professionals said that computer skills are "essential for employment" (Bassi, Gallagher, and Schroer 1996). By the 21st century, it is predicted that 60 percent of U.S. jobs will require computer skills (U.S. Department of Education 1996b).

Multimedia products are being used increasingly for formal training in the workplace. Lakewood Publications conducts a study of training in the workplace each year, surveying representative companies across corporate America. In 1996, they found that 37 percent of companies use CD-ROMs for some or all of their training, 22 percent use a company intranet, and 15 percent use the Internet (there was some overlap in responses). In addition, 10 percent use commercial satellite distance learning and 5 percent use company-owned satellite distance learning (Hamrin 1997). Brandon Hall, editor of *Multimedia and Internet Training Newsletter,* explains that Web-based training is not as popular now as CD-ROMs because of limited bandwidth; this limitation is expected to be overcome in the near future (Hall 1997). According to *EMedia Professional* (January 1997), Datamonitor USA reported that sales for multimedia training products for the business sector will reach $8 billion by 2005, with an additional $2 billion in home markets. In addition, *EMedia Professional* (February 1997) cites figures from Frost & Sullivan showing that the videoconferencing market is expected to reach $35 billion by 2002, increasing at an annual rate of 42 percent.

ASTD reports that in one year (1994–95), the percentage of technology-related training time for training organizations increased from 22 to 31 percent. It also reports that 75 percent of these organizations used interactive multimedia computer-based training in 1995, a large increase from

53 percent the previous year. Also in 1995, 55 percent of training organizations used televised distance learning; 83 percent of organizations expect to use multimedia CD-ROMs in the future, and 81 percent expect to use the Internet for training (Bassi, Gallagher, and Schroer 1996).

Benefits of Multimedia in the Workplace

ASTD reports that the use of technology in training is less costly than traditional training and allows workers to get training when and where they need it, leading to better work performance and fewer work interruptions (Bassi, Gallagher, and Schroer 1996). Hall (1997) says that the average time to train someone via computer is about half that of traditional instructor-led training, saving on both time and cost.

ASTD (1996) also reports that, when comparing multimedia training with traditional computer-based training, the majority of organizations feel that multimedia training provides better results in five areas they were questioned about: knowledge outcomes, performance outcomes, overall return on investment, retention, and instruction completion times.

Importance of Multimedia Access for People with Disabilities

In a series of interviews, numerous experts expressed the view that multimedia access for people with disabilities has become extremely important because it is being so widely used in educational settings and the workplace. George Kerscher, research director with Recording for the Blind and Dyslexic (1997), points out that almost all of the money now being spent by education publishers for research and development is going toward multimedia. Microsoft's David Bolnick (1997) adds that multimedia "is going to be everywhere." He notes, for example, that textbooks being provided in multimedia format will be updated much more rapidly than print books have been in the past. According to Larry Scadden of the National Science Foundation (1997), multimedia is "becoming the dominant part of the educational system and it will continue to grow. Disabled children don't have full access to instructional materials, and blind people are

the ones who are missing out the most." The impact on children and teachers with disabilities of not having multimedia access will become greater and greater. "It's slowing down the educational process and it's putting the blind kids at a greater disadvantage than they've had in quite a while," added Scadden.

Mary Ann Trower (1997), an education specialist with Edmark, echoes this concern, noting that multimedia is "a different way of learning and brings forth different concepts" and that disabled children will miss out if they cannot participate. In an interview, Tom Wlodkowski (1997) of NCAN spoke about the specific example of increasing numbers of students conducting science experiments using interactive multimedia CD-ROMs, and he laments that "blind students are locked out" of this activity. The importance of access to multimedia products is also emphasized by James Allan (1997), an instructor at the Texas School for the Blind and Visually Impaired, who notes that access to multimedia is "a critical need for anyone in any area of life" and that "having access to information can make or break you."

In discussing future trends, Kerscher believes that multimedia products will be written in Hypertext Markup Language (HTML), and it will not matter whether the delivery medium is a CD-ROM or the Internet. Currently transmission speed and capacity limit the amount of multimedia that is available over the Internet, but Kerscher is confident these issues will be overcome in the next five years. He also feels that schools will be using the Internet more and more and that increasing numbers of children will be educated at home with multimedia technology. He refers to the Internet as "the blackboard of the future." Scadden adds that there is time to avoid a crisis, especially with respect to access to the Internet, because the World Wide Web Consortium is interested in these issues and will provide guidelines for HTML development. CD-ROMs, though, will still be much more of a problem in the future. Similarly, Allen believes that the Internet is more likely to become accessible than CD-ROMs, because the Web Access Initiative is bringing Web stakeholders together to create standards for accessibility. He is not aware of any similar effort focusing on CD-ROM accessibility.

BARRIERS TO ACCESSING MULTIMEDIA

The most significant barriers preventing people with disabilities from achieving full and equal access to multimedia products are lack of knowledge and awareness among multimedia companies and the market they serve concerning access issues, the costs involved in developing access solutions, and technological challenges. Because the technology-based barriers and solutions involve targeted efforts to meet the needs of specific sensory disabilities, these will be discussed separately by disability.

Knowledge and Awareness

Probably the most often repeated reason for lack of accessibility of multimedia is the fact that software providers are largely unaware of the issues. IBM's James Thatcher (1997) believes the main reason for lack of accessibility is that software developers have not been educated in accessibility issues. In fact, he says that when developers do learn of access issues they are, in general, "both excited by and interested in learning how to make their products more accessible." Kerscher echoes this view, suggesting that developers simply do not know how to make their products accessible. According to NCAM's Madeleine Rothberg (1997), the issue of access is often not brought to the attention of software developers. Once it is, developers need to be able to incorporate fast, easy, reliable ways to build access in. They need to know that someone has found out how to do this and that it is not that difficult to achieve. Incorporating accessibility issues into the training of multimedia product designers at the university level as well as in ongoing training of those already employed in multimedia production would be a very useful first step.

The rapid improvement in technology capabilities also contributes to the problem of access. Computer manufacturers, software developers, and electronic information service providers are turning out more powerful computers, software, and high-speed, high-capacity communications networks, which enable consumers to use, produce, and transmit high-quality sound and video

images. As this new information technology increasingly renders the sounds, images, and textures of the real world in a virtual environment, those who attempt to provide technology access for people with sensory disabilities cannot keep up with the changes in new technology.

The World Wide Web illustrates the point. Perhaps more than any information distribution system before it, the Web presents an incredible opportunity for people with disabilities. In addition to providing a communication protocol that is potentially highly accessible and relatively easy to use, the Web can enable people with disabilities to pursue education, employment, and entrepreneurial opportunities never before thought possible. However, opportunity often implies challenge. One of those challenges is found in the current evolution of the Web as it moves from a text-based interface to a multimodal, multimedia operating environment. It is this environment that presents barriers to individuals with sensory disabilities.

Web sites that are primarily text-based are generally quite accessible to people who are deaf or hard of hearing, as well as to those who are blind or visually impaired. However, more and more sites are incorporating sound, graphics, and video. These sites impose barriers to users with hearing or seeing impairments. For example, individuals who can hear can go to the CNN Web site (http://www.cnn.com) and download video clips of important news events. However, individuals who are deaf or hard of hearing are denied access to the audio portion of the news, unless it is captioned.

Because the Web has become such an important resource for information and services, it is vital that Web sites be designed so that they are accessible to all users. A useful and quick reference that provides guidance on designing HTML pages can be found at the Trace Web site (http://trace.wisc.edu). This resource includes specifics on provision of text anchors, caption or text tracks, and text files (Vanderheiden 1996).

Financial Barriers

The cost of accessibility also ranked high as a significant barrier. Edmark's Trower says the biggest problem with building accessible software is the cost. Additional features need to be built in for a small number of people, while the software still has to sell for a reasonable cost on the general market. Barry Cronin of Addison Wesley Longman's Consumer Publishing Group (1997) notes that cost is a major factor, because over time it has become increasingly expensive to produce software, yet the price of software to consumers is being cut drastically. Because of cost, says Cronin, the company must engage in "compromise decision making" while trying to make its products accessible. For example, he notes that it is much more costly to pay for an actor's extra time to build his or her voice into additional audio tracks for products than it is to use existing hooks to create access through synthetic speech generated by a screen reader. He feels that most companies probably assume they will not make money by providing access but also do not believe they will sustain a loss. Cronin says approximate figures for costs are about $400,000 to $700,000 to produce a multimedia CD-ROM and about $10,000 to $15,000 to make it accessible. He believes that if his company produces CD-ROMs accessible to visually impaired children, and if they reach only 10 percent of the audience, his company will recoup its accessibility-related costs. In addition, providing accessibility could give the company a "unique differentiation" from other software companies.

Access Barriers for People Who Are Blind or Visually Impaired

The current state of multimedia access for persons who are blind is bleak. There is no commercial multimedia product available that has been shown to be fully accessible to individuals who are blind, and the outlook for access to multimedia for persons with low vision is only slightly better.

A key barrier to access to multimedia for people who are blind or visually impaired is the computer and software on which the multimedia technology itself depends. The widespread

acceptance of the graphical user interface (GUI) dramatically increased the computer access problems facing people who are blind or visually impaired. Access to computer-based productivity tools such as word processors, databases, and spreadsheet programs has not been adequately solved. The issues surrounding multimedia access must be integrated into the efforts to ensure access to computer hardware and software so that there is a coordinated, cooperative effort to ensure equality of access to critical information technology.

Because the programming and usability of GUI systems are quite different from those of text-based systems, many of the gains that blind computer users had made in terms of access have been severely hindered by the GUI. For example, in character-based systems, information is manipulated using only keystroke commands, whereas the GUI enables the individual user to manipulate visual representations of objects, usually in the form of icons, using a mouse or other pointing device. However, direct manipulation of icons using a pointing device is difficult or impossible for persons who are blind or who have other disabilities affecting their eye-hand coordination. Thus, keystroke commands that substitute for the actions carried out by a pointing device are required for such users.

While efforts have been under way for some time to enhance the accessibility of GUIs, the problem has become more complex as computer systems increasingly include multimedia capabilities. Microsoft's Bolnick articulated the challenge: "It's very hard for designers to conceive of being blind" and to envision what can be done and how the problems can be approached. Multimedia is heavily image-based, and those images can change rapidly, making it more difficult for a blind user to keep up with the changing status even if it is described. While the guidelines for captioning are well established, guidelines for the description of visual elements—such as text, charts, and pictures—need to be agreed upon and distributed in an easy-to-use format.

Trower notes that making multimedia products accessible to young blind and visually impaired children is especially difficult, because products for younger children are even more image-based

than multimedia directed toward those who are older. Scadden adds that while video description of the large amount of visual material may be helpful, many products already include continuous narration, making it difficult to add more audio on a video description track.

Access Barriers for People Who Are Deaf or Hard of Hearing

It is somewhat difficult to be optimistic about the speed at which access will be attained, especially if one looks at the history of access to other forms of media—for example, the telephone and television/video (King 1995, Strauss and Richardson 1991). It took almost 90 years before the first invention was created to provide deaf people with visual access to the telephone. Although the teletypewriter (TTY), developed in 1964, enabled individuals to communicate in print across telephone wires, it was not until the passage of Title IV of the Americans with Disabilities Act (ADA) in 1990 that Congress directed the establishment of telecommunications relay services (TRS) nationwide, enabling people with TTYs to communicate with people who have voice telephones. However, because TRS is a technology designed to retrofit a telephone network created without access for all, relay services remain slow (communication occurs at a rate no greater than one-third the speed of a voice conversation), cumbersome, and expensive.

With television, for which the first public broadcast occurred in England in 1927, it was 45 years (1972) before the first open captioned broadcast occurred and another eight years after that before the first closed-captioned broadcast took place in America in March 1980. Captioning of prime-time broadcast television, which is now highly successful, has been subsidized to a large degree by the Federal Government (the emphasis of federal funding is shifting to seed funding to encourage financial participation by the private sector) and increasingly through corporate advertising sponsorships. In 1993, the Television Decoder Circuitry Act became effective, requiring all televisions manufactured or imported into the United States with screens 13 inches or larger to have built-in decoders capable of displaying closed captions. New legislation requiring closed captioning of television programming was enacted in the Telecommunications

Act of 1996. The Federal Communications Commission (FCC) issued rules on captioning on August 8, 1997. Despite extensive development and consumer advocacy efforts, captioning continues to be viewed as an add-on or postproduction service rather than as a basic right and an integral aspect of the news, information, education, and entertainment milieu. For example, the vast majority of cable television remains uncaptioned (King 1995).

In addition to a general lack of captioning on cable programming, the number of available captioned videotapes remains low. Eighty percent of all general-interest videos and 95 percent of all educational videos are still not accessible to deaf and hard-of-hearing individuals; that is, they are not captioned (Gopen 1995). Nevertheless, one study reported that 94 percent of teachers of deaf and hard-of-hearing students used video at least once a week during the academic year (Harkins 1996). In that study, only 26 percent of these videos were captioned in their entirety (64 percent, some; 18 percent, none). The failure to caption resulted in heavy reliance on sign-language interpreters.

Based on a review of the Multimedia and Videodisc Compendium for Education and Training, only 3.5 percent of educational laser discs are identified as captioned. For entertainment laser discs (based on the Winter 1994 Laser Video File), approximately 17 percent are captioned. For CD audio used in computer-based multimedia products, virtually all such media are uncaptioned and thus inaccessible. Similar problems exist for file-based media—for example, digital audio and digital video (King 1995).

These statistics are especially disheartening when one considers that there are (1) standards for a two-track analog video closed-captioning system (in place since 1979); (2) substantial financial support mechanisms from the federal government for captioning of analog video; (3) six major captioning service providers and more than 100 small captioning service companies; and (4) more than 10 companies that provide tools for professionals and consumers to caption their own analog video (Berke 1997).

The situation is equally dismal for digital media. Although comparable accessibility statistics are not available for digital video and audio delivered on CD-ROMs, networked servers, or the Internet, the audio portion of most such products is inaccessible for deaf and hard of hearing people. The two consumer-level digital video formats (Apple's QuickTime and Video for Windows) include specifications for captioned text tracks; however, few developers are incorporating these. Only a very small number of companies (notably Microsoft and Broderbund) have committed to making future titles accessible (CAP-Media 1997).

Access Barriers for People Who Are Deaf-Blind

The Texas Education Agency report made two points about those who are deaf-blind. First, making visual information auditory is not enough—electronic text must be included, so that the information can be presented in braille. Any added audio descriptions should also be available in electronic format so that they are accessible to deaf-blind people. Second, there should always be a way to amplify auditory information for those who are blind and hard of hearing.

SOLUTIONS FOR MAKING MULTIMEDIA PRODUCTS ACCESSIBLE

Many solutions to technological barriers are likely to prove relatively easy to implement. Although it is an oversimplification, the main rules to keep in mind in attempting to make material accessible to individuals with vision or hearing disabilities are that everything visual must be described in text or aurally and that everything aural must be able to be seen.

Improving Access for People Who Are Blind or Visually Impaired

In our discussion with experts, there was some notable disagreement regarding the most effective means of ensuring access to multimedia. Some favored an approach that maximizes access by ensuring that multimedia products are accessible through screen readers. Others, notably Gregg Vanderheiden of the Trace Center (1996), argued for accessibility as part of the design of the mainstream product itself.

According to Barry Cronin of Addison Wesley Longman (1997), most accessibility does not need to be created by the software producers — in most cases, a software company must "just make sure their software works with existing screen readers." From a practical standpoint, IBM's James Thatcher (1997) argues that off-the-shelf access will not happen in any grand way and that therefore the focus needs to be on access products. Software developers should work to ensure compatibility with these access products when designing new software.

Vanderheiden counters that access products do not become effective for a year or two after new software is released and provide "only partial access pretty late in the game." As software products are being released faster, screen readers are falling farther behind. He believes that Microsoft's Active Accessibility is a move in the right direction, as Microsoft is putting the onus

back on the software developer. Edmark's Mary Ann Trower (1997) believes that universal design principles should be incorporated from the very beginning of software development.

Peter Korn of Sun Microsystems takes a middle ground. He maintains that for at least the next five years, information technology should not be considered "accessible" unless it is compatible with the screen access approaches used now by people with disabilities. However, he emphasizes that specialized screen access should not be the long-term approach because "it is an alternate interpretation of the visual expression of the information, rather than direct access to the information in a modality chosen by the user." (Korn 1997)

These differences of opinion deserve further consideration. Perhaps a national advisory task force could be convened to consider design and other multimedia access issues.

The Texas Education Agency (1997) wrote a report to the Texas legislature regarding the access issues related to electronic textbooks for blind or visually impaired students. It defines an accessible electronic textbook as one that disabled students can use and that achieves "the same intended benefit" as a comparable product for nondisabled students; in addition, the benefit should be achieved "with approximately the same amount of effort."

In implementing access strategies, there seems to be general agreement among experts on the solutions necessary for blind and visually impaired people to have full access to multimedia. A number of strategies and recommendations from various experts are summarized below (Lowney 1997, NCAM 1997b, Paciello 1997, Texas Education Agency 1997, Trace, 1997). The recommendations are not meant to be exhaustive but represent the types of solutions that are commonly suggested.

Customizable features. Use customizable sizes and types of fonts, customizable colors for fonts and backgrounds; allow user to customize interface timings; provide capability of focusing in and enlarging parts of the screen.

Mouse versus keyboard. Mouse access should never be the only method of access. Ensure that each feature has a keyboard equivalent and that it is documented; users should be able to explore mouse or keyboard functions without triggering unexpected changes.

Speech access. If speech is not built in, make sure that all aspects of the software operation and content are accessible with existing speech programs.

Access to graphical material. Graphical images should include video descriptions (see section below), either in written text format or by built-in voice. On the Internet, images should include "alternative text" attributes to describe what the images represent. NCAM uses a specific symbol (a D-tag) on its Web site to indicate that video description is available for a visual image.

Accessible documentation. In addition to making all online documentation accessible, software producers need to make any other documentation accessible (e.g., written documents, videotaped instructions).

Miscellaneous. Avoid bit-mapped text that cannot be interpreted by a screen reader, or provide an ASCII-based alternative text; all controls should be operable without having to see them; all buttons and keys need to be accessible (e.g., flat touch screens can include a scanning feature that would read aloud each option); status messages should be both aural and visual; the presence and direction of hypertext links need to be detectable.

Video Description for Visual Images

Video description is a proven method of providing the visual information contained in a video image to people who are blind or visually impaired. Video description (also known as audio description) refers to a means of making television, movies, and other video programming accessible through verbal (audio) descriptions of key visual elements that are inserted into natural pauses in the program's dialogue without interfering with the sounds and dialogue that are a

regular part of a video program. The narration enhances understanding and enjoyment of a video program by providing verbal descriptions of essential visual elements such as settings, action, comparative size, gestures, body language, scene changes, graphics, subtitles, and costumes. A study by the American Foundation for the Blind (Packer and Kirchner 1997) showed that those individuals with visual impairments who had experienced video description for television or video found it to be extremely important for their understanding and enjoyment of programming.

Although not yet used for enhancing access to interactive multimedia, video description is available in association with certain television programs and home videos. In addition to its use in television and video, video description has great potential for use in making computers and the Internet accessible to people with visual impairments. By incorporating video description into programs, these environments can be made meaningful to and usable by people who are blind or visually impaired. Microsoft Corporation (Bolnick 1997) is planning to incorporate video description capability into its new Synchronized Accessible Media Interchange (SAMI) technology, which will be used in making software accessible to people with disabilities.

The addition of video description to computer products would not only make them more accessible to visually impaired people but also to other people with disabilities (e.g., those with cognitive disabilities who might benefit from the use of description as an enhancement to their understanding of visual elements). Sighted people may find description helpful, particularly in circumstances where it is not convenient or possible to see a computer screen (many anecdotes attest to the value of video description in enabling sighted viewers to close their eyes or walk away from the television and still follow the program). A recent article in *The New York Times* (Bradsher 1997) reported that Microsoft Corporation is working on Internet access for people who are driving cars. The goal is to minimize the need for a driver to look at a computer screen, yet still allow him or her to access electronic mail and to be able to "surf" the Internet. The article states that there is already significant interest in using this technique, noting that California state troopers issue warnings to people who use laptop computers while they drive.

Improving Access for People Who Are Deaf or Hard of Hearing

Captioning for Auditory Access

Captioning is a long-standing effective method of conveying access to aural material for people who are deaf or hard of hearing through the display of subtitles or text description. Along with ensuring access for individuals who are deaf or hard of hearing, multimedia captioning provides enhanced usability for all consumers through searchable text, annotation, and hyperlink capabilities. Universal design in this sense would ensure full and independent access for people with disabilities (King 1997).

Many movie clips found on the Web are created with a software standard made by Apple called QuickTime. These clips are composed of separate video and audio tracks. Without much difficulty, a separate text track can also be added to the clip. This text track can become, in effect, a caption track. To see several examples of captioned movie clips, visit the NCAM Web site (http://ncam.wgbh.org).

Unfortunately, the availability of external captioning services and captioning tools has not persuaded the majority of analog video producers to include captions (CAP-Media 1996). When video and multimedia become digital, it is unlikely that the captioning situation will significantly change. The tools provided by Apple for captioning can be difficult to use. QuickTime captioning has been available for many years, but there are no commercial CD-ROMs that use this feature, and Web sites using QuickTime captions were created primarily as examples of how access could be achieved (King 1997). Microsoft's SAMI tools implementation will not begin for another six months and will likely be created for developers. Also, with regard to Windows 95/Windows NT, the captions are open, as opposed to closed. In addition, significant copyright issues need to be addressed, since these tools require making new copies of the media.

Captioning capacity—the ability to display text on the screen—should be incorporated into standard multimedia workstations. If properly designed into multimedia packages, captioning will not require separate equipment or software but will be affordable and available to anyone.

Speech Recognition

Speech recognition or speech-to-text technology changes so rapidly that research tends to be outdated as soon as it appears in print. Current focus would include Telephone Applications Program Interface (TAPI) and Speech Applications Program Interface (SAPI) standards. Microsoft is on the cutting edge with regard to TAPI and SAPI technologies. Research is also being done to determine whether SAPI and TAPI standards can be incorporated as part of the telephone network. There is a very strong movement at this time to make speech recognition an integral part of multimedia applications (Jensema 1997). It is anticipated that a variety of materials with speech-to-text capabilities will be coming out in a year or so. The industry perceives speech recognition as the wave of the future because of the higher speed of the spoken word and the convenience of not using keyboards. Dragon Software, for instance, just came out with the first continuous, speaker-independent recognition system for personal computers. With normal speech, this software can handle 100 words per minute with 95 percent accuracy.

Speech-to-text and text-to-speech technologies hold much promise. In addition, imagine the breakthroughs that could result from approaches that would allow the translation of American Sign Language (ASL) to text or text to ASL.

VOLUNTARY EFFORTS TO IMPROVE ACCESS TO MULTIMEDIA

Several efforts designed to address barriers and improve access to multimedia technology are under way. These activities can be divided into three categories:

1. Development of access guidelines for technical assistance
2. Individual company-led access-related efforts
3. Industry-led voluntary guidelines/standards

Access Guidelines

This effort is best illustrated by the work taking place at the National Center on Accessible Media (NCAM), housed at WGBH in Boston. NCAM is working on a National Science Foundation–funded project to make science and math CD-ROMs accessible to people with low vision or blindness. The first year of this three-year project will be spent identifying the barriers in existing science and math CD-ROMs, and the second year's activities will involve teaming up with a multimedia software publisher to make a prototype of an accessible CD-ROM and developing access guidelines and techniques that can be incorporated by developers into their products. The third year will involve finalizing design guidelines and disseminating them widely to those who are in a position to incorporate the guidelines into software products.

Company-Led Efforts

Mary Ann Trower (1997) of Edmark, a publisher of children's educational software, believes that universal design principles should be the aim from the very beginning of software development. Edmark produces software for children from preschool to high school and has built many

accessibility features into much of their software. She says that building in the additional features from the beginning is a lot less expensive than retrofitting products.

Some of the ways that Edmark has built in access for visually impaired children is by keeping the computer screen "clear and simple," using font sizes as large as possible, and having large response spaces on the screen. She says "as ages go up, you end up with smaller spaces and smaller places, and faster action," which adds to the difficulty.

Edmark software is available for IntelliKeys, so that overlays developed for blind children can work with it. Trower is currently working on a project looking at ways of adding "scripting" on Edmark's software, whereby certain elements of the screen would be verbalized as a mouse was moved over those sections.

Broderbund provides another example (Broderbund 1997). Its Software Education Division has contracted with the Alliance for Technology Access (ATA) to test Broderbund's software with various assistive devices and create a list of Broderbund products that can be accessed with each device. Among the devices listed are various screen enlargement programs, such as inLarge, and alternative keyboard access programs, such as IntelliKeys. At this writing, 23 products have gone through ATA's testing process.

A number of Broderbund's products have both visual and auditory output built in. As an example, "Where in the World Is Carmen Sandiego?" reads aloud everything that is written; however, it is not fully accessible to people who are blind because it still requires clicking in particular areas. In Broderbund's "Living Books" series, an entire story can be read aloud. This software includes alternative keyboard commands and a scanning feature whereby one can have various options read aloud. Broderbund is continuing to look at additional accessibility issues in its products and is trying to broaden its scope of access.

According to Barry Cronin (1997), Addison Wesley Longman's Consumer Publishing Group products either will have voiceable text built in or will be accessible with a screen reader. In some cases, they will feature a combination of both. The decision of which to use depends on a number of factors, particularly the cost involved. Because of the issue of cost, says Cronin, the company must engage in "compromise decision making" while trying to make its products accessible. Its main goal is addressed by the question, "Will this product be understandable, enjoyable, and easy to use for a child with a disability?" The company's planners do not believe they will make money by providing access, but they also believe they will not sustain a loss.

Microsoft's Accessibility Home Page (Microsoft 1997) recently announced its new Accessibility and Disabilities Web site. Included are several recent and particularly relevant announcements, the most notable one regarding the new Microsoft Synchronized Accessible Media Interchange (SAMI) format, scheduled for distribution by the end of 1997. This new format will enable software developers who create multimedia software titles and Web pages to provide closed captioning for users who are deaf or hard of hearing. Microsoft has also announced release of new guidelines for accessible Web page design to take advantage of accessibility features in its Internet Explorer Web browser. Other announcements include Microsoft's release of Active Accessibility (MSAA) 1.0, new technology to make better accessibility aids and more accessible applications, and the version 3.0 release of the Designed for Windows NT and Windows 95 logo program, containing four new accessibility requirements.

An important caveat should be kept in mind: It will be some time yet before the new Microsoft SAMI technology is disseminated and fully put into practice—the critical step is getting mainstream software developers to use this technology, across the board. Similarly, MSAA is not widely used at this time, and its potential cannot be assessed until both mainstream and adaptive software developers begin implementing it.

Sun Microsystems has also undertaken efforts to address the accessibility of one of its key technologies, Java, an object-oriented programming language. Applications developed in Java

are capable of running on several different platforms (e.g., Windows, Mac, and Unix). Java software applications can also be created for consumer products such as copiers and cellular phones. This cross-platform operation has made Java a popular programming language for the World Wide Web and other network environments.

Sun has released Early Access, interim editions of the Java Accessibility API (applications program interface). Peter Korn (1997) describes this API as a contract detailing how programs written in Java will communicate with assistive technologies such as screen readers. Korn says Sun is implementing the accessibility API as part of the Java Foundation Classes (JFC), a new set of building blocks for designing the user interfaces of Java programs. These building blocks are supposed to be as modality-independent as possible. Ultimately, Korn says, programs built with the JFC will be compatible with screen readers. Korn predicts that the Java Accessibility API will be incorporated into the next release of the Java Development Kit (JDK), scheduled for early next year. Korn says that the goal is for the user interaction to be "pluggable," meaning that a user may choose an alternative modality such as speech or braille rather than a keyboard, mouse, or visual display. Thus, the user can interact with the Java application in his or her preferred modality (Korn 1997).

Again important caveats should be kept in mind regarding Java and its accessibility components: It will be some time yet before Java has significant market share, and its potential cannot be truly assessed until it is supported by both mainstream and adaptive software developers. It does raise the possibility, however, that multimedia products as well as to personal computer applications (e.g., consumer electronics) may benefit from underlying accessibility in a broadly deployed Java language environment.

Industry-Led Efforts

Web Access Initiative

The World Wide Web Consortium (W3C), which includes more than 200 companies and organizations, has established the Web Access Initiative (WAI). The purpose of this initiative is to ensure that the protocols and procedures developed and promoted by the W3C incorporate the needs of persons with disabilities.

The activities related to the WAI are overseen by an International Program Office (IPO) and several work groups. Each group focuses on different activities—for example, ensuring the accessibility of basic elements of the Web, such as HTML and data formats; creating accessibility guidelines for developers of Web sites, Web browsers, and Web authoring tools; and establishing criteria for rating the accessibility of Web sites. (see http://www.w3.org/WAI/group). The IPO helps coordinate the efforts of the work groups and educates key players in the Web industry. In addition, the IPO helps ensure that disability organizations, people with disabilities, and other interested parties can participate in WAI activities.

Together, these efforts represent a significant breakthrough for persons with disabilities. Rarely have the needs of persons with disabilities been considered during the early days of a new technology such as the World Wide Web. While much work remains, the collaboration put in place by the WAI offers tremendous encouragement to the disability community. This initiative could serve as a model for future collaborative efforts.

Advanced Television

Advanced television (ATV), also known as high-definition television (HDTV), is a complete redesign of North America's television service. ATV will be completely digital, with a sharper picture, an aspect ratio resembling that of a wide-screen movie, multiple CD-quality audio channels, and ancillary data services. The creation of ATV necessitates the creation of a new captioning system and offers the potential of convenient delivery of video description over one of the multiple audio channels that can be accommodated within each digital signal. In addition,

ATV will make exciting new caption features possible, such as multiple caption streams (enabling viewers to choose among different languages or different reading speeds); a wider range of character sizes, fonts, and colors; and increased flexibility with regard to caption placement.

To ensure the development of a captioning system that serves the needs of viewers now and in the future, the Television Data Systems Subcommittee of the Electronic Industries Association formed a working group on ATV closed captioning. This working group consists of the top three caption service providers (the Caption Center, the National Captioning Institute, and VITAC); major caption hardware and software companies (Avio Systems, EEG Enterprises and SoftTouch); major receiver manufacturers (Panasonic, Philips, Thomson, and Zenith); and a leading manufacturer of digital TV hardware (General Instruments). The working group is determining the features, display protocols, instruction sets, and transmission methods for an optimal captioning system that will serve current and future users of captioning (NCAM 1997c).

Although the digital TV standard allows for inclusion of an audio track for the purpose of delivering video description, the FCC has thus far not ordered a set-aside of audio bandwidth for this purpose (FCC 1996). In addition, manufacturers of digital television receivers are not yet required to support simultaneous multichannel audio-decoding capability, which would enable video descriptions to be delivered separately from a program's main audio and would thus have the potential to lower costs considerably.

Association to Promote Access Engineering

A working group of disability and technology industry representatives has formed the Association of Access Engineering Specialists (AAES) under the National Association of Radio and Telecommunications Engineers (NARTE). AAES has the following purpose: "to promote the development of engineering for disability access and to support an ongoing dialogue between the disability community and industry regarding access issues." The initial focus of AAES will

include developing a knowledge base, providing educational opportunities, distributing information regarding access engineering, and initiating standards coordination (NARTE 1997).

Information Infrastructure Standards Development

The Information Infrastructure Standards Panel (IISP) has been convened by the American National Standards Institute to review the need for coordination and development of additional information technology standards. Several initiatives under consideration by this panel are likely to be relevant to standardization of multimedia technologies—for example, nomadicity and electronic publishing.

RECOMMENDATIONS FOR FURTHER ACTION

National Advisory Task Force on Multimedia Access

Based on the experience of the Texas Education Agency Task Force and the work of the Access Board's Telecommunications Access Advisory Committee, *a national advisory task force comprised of representatives of industry, government, and the disability community should be convened to work toward an agreement on accessibility guidelines for multimedia technology.* The U.S. Department of Education may be in the best position to convene such a task force, because of the extensive use of multimedia in educational materials. Alternatively, the Access Board may be an appropriate entity to carry out such an activity, drawing upon work it has done developing accessibility guidelines under Section 255 of the Telecommunications Act and (potentially) Section 508 of the Rehabilitation Act.

Some of the issues to be considered by such a national task force would include

- organizational processes to ensure consideration of accessibility (universal design) at all levels of product development and delivery;
- built-in access versus access via assistive technology such as screen readers and specialized input devices;
- industry-based or government-established standards versus voluntary guidelines;
- techniques for accessible input, output, and controls;
- methods to provide access to online help and product documentation; and
- methods to ensure customer support for disability access.

Legislative/Regulatory Policies

Congress and the administration should develop and implement legislative/regulatory policies to improve access to multimedia. For example, Section 508 of the Rehabilitation Act should be strengthened to promote access through government procurement of accessible information technology, exemptions from copyright restrictions to add accessibility through captions or video description, and tax credits or other financial incentives to support and promote the development of accessible multimedia technology.

Universal design concepts should be included in industry standards and guidelines for multimedia products. Technology industries are changing at a revolutionary pace. It is important that access issues be incorporated into new standards as early as possible if universal access is to become the rule rather than the exception. The Access Board's Telecommunications Act Accessibility Guidelines and the ongoing efforts of the World Wide Web Access Initiative provide encouraging examples of efforts to improve access to information technology. Multimedia-related standard-setting activities should be expanded to stimulate accessibility.

Government Procurement of Accessible Information Technology

Section 508 of the Rehabilitation Act requires federal agencies to comply with accessibility guidelines in the procurement of information technology. Enforcement of this law has proven inadequate, and many federal agencies purchase information technology that does not comply. Recently, amendments have been introduced in Congress to increase compliance with Section 508. For example, H.R. 1255, the Federal Electronic and Information Technology Accessibility Compliance Act of 1997, would require federal agencies to certify compliance annually, with oversight by the Office of Management and Budget. A companion bill has been introduced in the Senate. Efforts are also under way in the Senate to expand the scope and enforcement of Section 508 by assigning authority to the Access Board for regulations. The as-yet-unrealized intent of Section 508 has been to take advantage of the purchasing power of the Federal

Government to create a market-based incentive for the production of accessible technologies and to ensure that they are usable by the 145,000 federal employees with disabilities.

Implementation of the Telecommunications Act

The legislative history of the Telecommunications Act of 1996 clearly shows that Congress intended the Federal Communications Commission (FCC) to regulate Section 255, Access by Persons with Disabilities. At the time of this publication, however, the FCC has not issued or even proposed such regulations. The unfortunate result is that new telecommunications technologies and services, many of which are multimedia in nature, have been emerging each week without significant attention to universal design. The FCC must fully and speedily exercise its authority in this area to prevent unnecessary barriers to people with disabilities on the burgeoning information superhighway.

Copyright Reform

In 1996, Congress enacted legislation that eliminated the need to obtain the permission of publishers or copyright owners if an authorized entity wishes to reproduce or distribute a nondramatic literary work in a specialized format for the exclusive use of blind persons or others with physical disabilities. The law defines authorized entities as nonprofit organizations or governmental agencies whose primary mission is to provide specialized services related to the training, education, adaptive reading, or information access needs of blind or other persons with disabilities. "Specialized formats" specifically include braille, audio, or digital text exclusively for use by blind or other persons with disabilities. "Blind or other persons with disabilities" means individuals who are eligible to receive specialized library services under definitions used by the National Library Service for the Blind and Physically Handicapped of the Library of Congress.

To date, no similar exemption from the copyright requirements exists for adding captioning or video description. Accordingly, it remains extremely burdensome to add captions or video description to copyrighted works, including videotapes and computer media, needed for instructional programming. Often, obtaining such permission can take upwards of six months, eliminating entirely the benefits of such materials for educators and students during a given semester. Legislation granting an exemption from copyright restrictions in order to reproduce such materials for the purpose of adding accessibility through captions or video description may be a useful step.

Incentives

Tax credits or other financial incentives could be crafted to support and promote the development of accessible multimedia technology, especially technology designed for employment or education. For example, the R&D Tax Credit was originally signed into law in 1981 as part of the Economic Recovery Tax Act (ERTA, P.L. 97–34). Corporations received a tax credit ranging from 1.65 percent to 20 percent for qualified R&D expenditures (QREs) that exceeded a certain fixed base amount. QREs had to be technological in nature and relate to the development of new or improved business products. This credit expired on May 31, 1997. Industry-supported efforts are under way to make the credit permanent. To the extent that incentives are continued or expanded, companies receiving incentives must be held accountable for their disability access obligations, including those under the Americans with Disabilities Act and the Telecommunications Act.

PCTV Accessibility

Many personal computers now have television circuitry that enables the computer to receive and display television signals. In March 1995, the FCC issued a ruling requiring computer systems that have the capability of receiving television signals and that are sold with monitors that have a viewable picture size of 13 inches or larger to have built-in circuitry to decode and display closed

captions. The FCC has based its ruling on the requirements of the Television Decoder Circuitry Act of 1990. The FCC's ruling exempted (1) computers that are sold without monitors but that have television reception capability and (2) separate plug-in circuit boards that can be used to add television reception capability to an existing personal computer. In December 1995, several consumer organizations representing deaf and hard-of-hearing individuals filed a petition for rulemaking requesting that the FCC require all computer components with television reception capability—whether or not such components are sold with a monitor—to be equipped with circuitry capable of decoding closed captions. This petition is now pending in the FCC's Office of Engineering and Technology.

State Action

Texas has taken a leadership role in analyzing and attempting to remove the access barriers posed by multimedia-based educational material. Texas was an early adopter of legislation designed to advance the availability of braille textbooks, including a requirement that publishers provide electronic versions of textbooks for braille production. Subsequent concerns about access to multimedia textbooks led to the Texas Education Agency's convening a task force to address access to multimedia material. On June 20, 1997, Texas governor George W. Bush signed Senate Bill 294, which calls for a study of the costs and benefits of using computer networks in Texas schools and creates a subcommittee to "investigate the feasibility and cost-effectiveness of developing electronic textbooks that may be used by students who are blind or have other disabilities." It is conceivable that the state will eventually require electronic textbooks to be accessible.

Research, Education, and Collaboration

Government agencies, private corporations and foundations should conduct research on information technology access issues and the development of solutions. People involved in all

aspects of the development of multimedia and other information technology should be educated about access issues.

Support is needed for research examining the technological and social issues surrounding access to multimedia and other information technology by persons with disabilities and the benefits of such access to individuals who are not considered disabled. In particular, research is needed on ways to make visual and aural information accessible to individuals with sensory disabilities.

Various government agencies fund research activities related to information technology and disability access. Principal among these agencies are the National Science Foundation, the Department of Commerce (National Telecommunications and Information Administration and National Institute on Standards and Technology), and the Department of Education (National Institute on Disability and Rehabilitation Research). These agencies should be encouraged to fund further research into methods that enhance access to information technology for people with disabilities.

Mainstream technology and multimedia developers, producers of assistive technology, disability organizations, and research institutions should strengthen partnerships aimed at developing access and usability solutions. Use of multimedia products and other information technology by persons with disabilities is not well documented or understood. Mainstream developers who now rarely include persons with disabilities in marketing or usability surveys must do so. Furthermore, efforts to improve access and usability through assistive technology should be improved. In addition, though experts differ on the extent to which multimedia products will ever be accessible "out of the box" (built-in access does not appear imminent), efforts to improve the accessibility of mainstream products must be greatly expanded.

The development, sale, and use of information technology involves many people—educators, content providers, programmers, marketers, engineers, end users, and so on. If equal access to multimedia for people with disabilities is to become a reality, knowledge and awareness will

have to be developed across all areas. Innovative methods to instruct those currently involved in the information technology and multimedia industry about access issues and solutions must be developed. The training and information dissemination efforts now being undertaken by the Association of Access Engineering Specialists provide a good example of such innovation. Enlisting the support and interest of university faculty and other experts across many disciplines—from computer science to publishing to education—is also important.

APPENDIX A

FRAMEWORK OF MULTIMEDIA CATEGORIES

In an attempt to circumscribe our working definition of multimedia and our parameters for this project, we sought a useful way to categorize multimedia-related terminology. Gregg Vanderheiden, director of the Trace Center, divides information technology into a three-part typology consisting of source material, transmission mechanisms, and viewer/controller equipment. We tentatively suggest the following organizing framework[1] as a useful way to approach multimedia issues:[2]

Interactive Multimedia[3]

I. Delivery[4]

A. Transmission

1. Fixed transportable media (e.g., CD-ROMs, digital video disks, floppy disks)
2. Phone lines and other wired communications (e.g., cable)
3. Short- and long-range wireless (e.g., infrared, satellite)

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[1]The list of examples below is not meant to be exhaustive, but to be representative of those technologies that currently exist while being flexible enough to incorporate new technologies that are currently being developed or are not yet in existence.

[2]This typology differs from Vanderheiden's in that it elaborates on the different types of visual and aural outputs that exist. In addition, it categorizes viewer/control devices and transmission under the larger heading of "delivery" and adds under this major heading the separate category of "underlying control software."

[3]We do not include videotape materials in this list as they are not interactive.

[4]The Internet, including the World Wide Web, is not specifically mentioned on this list as it is a "meta-construct"—it uses varying combinations of transmission, control devices, and control software and does not fit neatly into any one of the delivery categories.

B. Viewer/control devices[5]

1. Kiosks
2. Attachments/terminating devices for phone lines, wireless, etc.
3. Computers
4. Digital television

C. Underlying control software

1. Web browsers
2. Content/organization software (e.g., HTML, VRML, XML, Java)
3. Proprietary presentation applications (e.g., operating systems, Lotus Notes, Adobe, individual banks' ATM software)

II. Content/product elements[6]

A. Visual Output

1. Icons (e.g., buttons, list boxes)
2. Still photos
3. Full-motion video
4. Still pictorial drawings
5. Numerically based graphs
6. Typographical text
7. Handwritten (bit-mapped) text
8. Maps
9. Marquees/tickertape

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[5]These involve both hardware and software elements.

[6]These elements can be used singly or together to create books, Web sites, games, television/videos, e-mail, instructional material/distance learning, and so on.

10. Animation[7]

11. 3-D[8]/(visual)[9] virtual reality[10]

B. Aural output

1. Beeps/bleeps
2. Synthetic speech
3. Digitized human speech
4. Ambient sounds
5. Voice inflections
6. Music
7. 3-D audio[11]

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[7]Animation typically refers to animated drawings; however, most visual images can be animated.

[8]3-D is a technique that can be applied to any of the above visual elements.

[9]Virtual reality can also be created using other senses (e.g., using movement or touch).

[10]Virtual reality may use a combination of the above visual elements.

[11]Stereo audio designed to give a sense of location, relative to the listener, to the sounds heard. Can be a combination of the above aural elements.

APPENDIX B

NUMBERS OF PEOPLE WHO ARE BLIND OR VISUALLY IMPAIRED AND PEOPLE WHOM ARE DEAF OR HARD OF HEARING IN THE UNITED STATES

Number of Persons in the United States Who Are Blind or Visually Impaired

Two recurring federal surveys provide national estimates of "visual impairment" that cannot be corrected to "normal" by ordinary eyeglasses or contact lenses. A widely used broad measure comes from the annual Health Interview Survey (HIS) of the National Center for Health Statistics (NCHS), a division of the Centers for Disease Control and Prevention. In 1994, HIS's household-based sample estimated 8,601,000 people with "trouble seeing even with glasses, if used" (NCHS 1995). A reanalysis of HIS data collected from 1989 to 1994 (Packer and Kirchner 1997) shows that an estimated 500,000 report that they are "blind in both eyes."

The main alternative estimate of visual impairment that comes from a federal survey of households is found in the Bureau of the Census Survey of Income and Program Participation (SIPP). In 1991–92, SIPP's broad measure yielded an estimate of nearly 10 million people who reported "difficulty seeing the words and letters in ordinary newspaper print, even when wearing glasses or contact lenses (if the person usually wears them)" (McNeil 1993). Within that group, a subgroup of 1.6 million people reported that they were "not able to see the words and letters at all."

In addition to the household-based sample, people in long-term care institutions, mainly nursing homes, include many who have severe visual impairment. From the 1985 NCHS National Nursing Home Survey (NNHS), we estimate that 338,200 institutionalized persons are blind or have "partial or severe visual impairment" (NCHS 1989).

To summarize, for the United States in the early 1990s, the broad estimates we have identified range from 8.9 million to 10.3 million persons who have a visual disability.

Number of Persons in the United States Who Are Deaf or Hard of Hearing

The National Institute on Deafness and Other Communicative Disorders (NIDCD) has indicated that there are at least 28 million deaf, late-deafened, and hard-of-hearing people in the United States. According to the League for the Hard of Hearing in New York City, the NIDCD confirmed the accuracy of this statistic in July 1996. The Council of Organizational Representatives has also adopted this statistic as an accurate indication of the total population of deaf and hard-of-hearing individuals in this country (COR 1996).

The deaf and hard-of-hearing population is also estimated by NCHS. According to its 1990 and 1991 HIS, approximately 20 million persons, or 8.6 percent of the total U.S. population three years and older, were reported to have hearing impairment. Persons 65 years and older were eight times more likely to have hearing impairment than persons aged 18 through 34—29.1 percent and 3.4 percent, respectively (NCHS 1994). Note that these data do not include children three years of age and younger.

Use of Computers and the Internet by People with Disabilities

Research has shown that people with disabilities use computers and the Internet in large numbers.

The results from an ongoing survey of World Wide Web users conducted by the Georgia Institute of Technology (1996), show that 8 percent of users report having disabilities. Almost half of those with disabilities (3.7 percent of the total) report having visual impairments. This number may be somewhat higher if those who identified themselves as multiply handicapped also have visual impairments. All other types of disabilities were reported at less than 1 percent each.

A national study conducted by the American Foundation for the Blind in 1995 (AFB 1996) found that the percentage of blind and visually impaired people who have a personal computer in their household (29 percent) is similar to figures for the general population reported by other sources: 40 percent (Electronic Industries Association 1996), 38 percent (Wirthlin Worldwide 1996), 25 percent (Roper 1995). The percentage of respondents in AFB's study who had personally used a computer in the past year was 38 percent; of these, 59 percent had used a computer at work and 54 percent at home in the past year. Data for the general population show that 34 percent have used a personal computer, 68 percent at work and 50 percent at home (Roper 1995). Of those in AFB's study who had used a computer in the past year, 31 percent had access to online computer services or the Internet (12 percent of the entire sample of 417). These figures are within the range found for the percentage of the general population that was online; general population figures vary quite a bit because of various methodological and timing issues, and ranged at that time from as low as 4 percent (FIND/SVP 1997) to as high as 22 percent (Nielsen 1996). The number of Internet users in the general population has been increasing substantially (Werbach 1997, Wirthlin Worldwide 1996). Jupiter Communications, cited in *EMedia Professional* (February 1997), predicts that the number of households online by 2000 will triple from 1996 numbers. We fully expect that Internet use will continue to increase substantially for blind and visually impaired persons as well, provided that the Internet remains accessible.

In another study, Kirchner and Harkins (1991) found that among visually impaired people who are employed, those who have no useful vision appear to have higher rates of computer use than those who have a lesser degree of visual impairment. Blind and visually impaired people tend to be poorer, on average, than the general population and tend to be employed much less often (McNeil 1993). Studies have shown that computer users and Internet users tend to have higher income than the general population (Georgia Institute of Technology 1996, Response Analysis Corporation 1996, Wirthlin Worldwide 1996), that people tend to use computers at work more than at home (Roper 1995) and that many people's Internet access is provided by work (Georgia Institute of Technology 1996). It is particularly noteworthy, given their generally lower income and rate of employment, that blind and visually impaired persons use computers and the Internet

at rates similar to those of the general population, suggesting the increased importance of this access to them.

With access to some computer technology through ASCII on their text telephones, the number of potential deaf and hard of hearing users increases, according to Judy Viera of Teletec (1997). Robert Scheffel of the Oregon School for the Deaf (1997) estimates that about 95 percent of deaf and hard-of-hearing students attending residential schools have access to computers, and Ed Bosson of the Texas Public Utilities Commission (1997) estimates that about 9.3 million deaf and hard-of-hearing Americans make use of ASCII, through either computers or text telephones.

According to Scheffel, about 30 percent to 50 percent of deaf and hard-of-hearing children in residential schools have access to the Internet, and Viera says that 40 percent of deaf and hard-of-hearing people of all ages who have access to ASCII are estimated to have access to Internet.

APPENDIX C

SURVEY OF EDUCATORS OF BLIND/VISUALLY IMPAIRED PERSONS WORKING WITH MULTIMEDIA PRODUCTS

As part of a contract from the National Council on Disability, we are exploring how **blind and visually impaired** people are affected by the use of multimedia products (that is, products that transmit both *visual* and *auditory* output, such as CD-ROMs or World Wide Web pages).

We're looking for educators who are on the "front line," using or attempting to use multimedia materials in their curricula, to share some of their experiences with us. We feel that your hands-on experience in this area will be extremely valuable in examining the types of multimedia products being used or adapted, and the types of problems visually impaired students encounter.

We are interested in your personal experiences, and personal opinions. You may answer any or all of the following questions, or you may choose to relay your experiences to us in whatever manner you feel most comfortable. Thank you in advance for helping us to understand this increasingly complex issue.

Please e-mail your responses to jpacker@afb.org. We would like to receive your answers back by a week from the posted date, if at all possible.

Jaclyn Packer, Ph.D.
Senior Research Associate
American Foundation for the Blind

QUESTIONS:

1. What types of multimedia products (that is, products that transmit both visual and auditory output) have you used?

2. Have your visually impaired students used multimedia in the regular education classroom and/or special education classroom? In what grade levels and/or subject areas? Have you used these products with children who are multiply handicapped?

3. What types of problems have you encountered in using multimedia products with visually impaired children?

4. Are there multimedia titles other students use that your visually impaired students are unable to access? What are those titles/publishers?

5. Are there multimedia titles that your visually impaired students are successfully accessing? What are those titles/publishers?

6. What type of setting do you teach in (e.g., residential school for the visually impaired, special class, itinerant teacher, teacher consultant)?

7. Have you seen any advantages in using multimedia products with blind or visually impaired children? What are the advantages?

8. What assistive technology, if any, are you using to access multimedia products (e.g., synthetic speech, braille, screen magnification)? Please tell us the product name and manufacturer.

9. If you have used any other methods or adaptations so that the multimedia products you used would be more accessible, please describe these adaptations.

10. In your opinion, what types of multimedia provide the best access for children who have visual impairments? The worst access?

11. Have you had any special training in adapting multimedia materials for your visually impaired students? What type of training?

Please note: We may wish to follow up on your response via e-mail or telephone in order to get more information from you. **If you are willing, please let us know your telephone/TTY number and/or e-mail address.**

APPENDIX D

RESULTS OF QUESTIONNAIRE FOR EDUCATORS OF PEOPLE WHO ARE BLIND/VISUALLY IMPAIRED

In March 1997, the American Foundation for the Blind developed a questionnaire aimed at educators who have used (or attempted to use) multimedia products with blind and visually impaired children. Educators were asked numerous questions (see appendix C, above, for full questionnaire) concerning assistive technology used, titles used, problems encountered, and opinions about the importance of access to multimedia in education.

This questionnaire was distributed widely over the Internet to various e-mail discussion lists that focus on technology access, education of blind and visually impaired children, deaf-blind children, or special education in general, as well as those that focus on multimedia in the education of children.* In addition, the questionnaire was posted to several private lists of Web sites, including that of the Alliance for Technology Access, Council of Schools for the Blind (COSB), and a list of braille teachers maintained by AFB. The Internet was chosen as a method of distribution because people dealing with multimedia would be likely to be Internet users, and because distributing a survey over the Internet can be a relatively quick way to get useful qualitative information.

The majority of responses came within a week of posting. In total, we received 20 responses, of which only 8 answered at least some of the questions we posed about children. Nine of the

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*The Educator Questionnaire was posted on the following lists in March 1997: EASI, VI-OUT, ACCESS-L, DEAFBLIND, ABLETECH-L, DVH-S, AERNET, BLINDFAM, EDTECH, and AMTECH.

remaining 12 were requests for information on the topic that we were studying, and 3 were responses sharing information about multimedia but not specifically about children and education.

The fact that there were so few responses to the questionnaire (particularly from teachers) may reflect that very few educators working with visually impaired children are actually using multimedia products or have access to the Internet.

Answers from the small number of respondents are not necessarily representative of educators working with visually impaired students. Of the 8 respondents, 7 were from the United States and 1 was from Canada. Very few were actually teachers; four worked in school libraries and the remaining four were an outreach consultant for a residential school, an itinerant teacher, an educational consultant in a rural area, and a person working at an independent living center.

Respondents say they are using multimedia products with blind and visually impaired children at all grade levels and with children who have other disabilities in addition to visual impairment.

Below are some of the types of multimedia that respondents indicated their students are using. It is important to note that, in most cases, the respondent did not specifically state whether the children using the software were blind or had low vision. In addition, respondents did not specify how accessible the products were to the children, only that they were using them. It is important to keep these points in mind because, while educators say children are using these products, currently no multimedia software is available that is fully accessible to people who are blind or visually impaired.

Multimedia products respondents say they are using in the schools include encyclopedias and other reference materials, magazines and journals, children's games, and assorted instructional and creative products. These products are delivered by CD-ROM or over the Internet. Of all the

types of products named, CD-ROM encyclopedias were named most often. In particular, the following encyclopedias are being used: Grolier, Encarta, World Book, and Compton.

Among the reference materials cited as being used with visually impaired children were the following: Magazine Index, Microsoft reference products, Time Almanac, and Sports Illustrated Almanac.

Internet browsers mentioned by respondents were Netscape Navigator (cited by two respondents), Webspeak, and Lynx.

Other software (not an exhaustive list) included Learn to Type, Wide World of Animals, Thinking Things, Windows on Science, KidWorks, Bailey's Book House, Millie's Math House, and HyperStudio.

Adapted equipment being used in the schools included Zoomtext; Enlarge, Outspoken, Biggie Cursor, JAWS, MegaDots, Vocal Eyes, Doubletalk, Braille 'n Speak, Magic, Closeview, and Intellitools.

Respondents mentioned numerous benefits of access to multimedia by blind and visually impaired students, including excitement, interest, motivation, independence, improved self-esteem, improved listening skills, access to materials in very rural areas, and increased ability to get relevant materials in a student's preferred medium. Many of these benefits are the same as those that children without disabilities obtain from interacting with multimedia products.

APPENDIX E

QUESTIONS FOR EDUCATORS AND MEDIA SPECIALISTS OF PERSONS WHO ARE DEAF OR HARD OF HEARING

1. What types of multimedia products (that transmit both visual and auditory output) have you used?

2. Have deaf and/or hard-of-hearing individuals used multimedia in various settings, such as in a regular education and/or special education classroom, workplace, or at home?

3. In what grade levels and/or subject areas?

4. What types of problems have you encountered in using multimedia products with deaf and hard-of-hearing individuals?

5. Are there multimedia titles that deaf and hard-of-hearing individuals are successfully accessing? What are those titles?

6. Are there multimedia titles that deaf and hard of hearing individuals are unable to access? What are those titles?

7. What type of setting are you in (i.e., residential school, special class, teacher, trainer, consumer)?

8. Have you seen any advantages in using multimedia products with deaf and hard-of-hearing individuals? What are the advantages?

9. What assistive technology, if any, are you using to access multimedia products (i.e., speech recognition, captioning)? What are the product and manufacturer names?

10. If you have used any other methods or adaptations so that the multimedia products you used would be more accessible, please describe these adaptations.

11. In your opinion, what types of multimedia provide the best access to deaf and hard-of-hearing individuals? The worst access?

12. In your opinion, what is the quality of accessible media? Was the captioning verbatim and simultaneous?

13. Have you had any training in adapting multimedia materials? What type of training?

14. Does your hardware include audio equipment (i.e., speakers)? If not, is your hardware interoperable with multimedia programs?

APPENDIX F

CURRENT MULTIMEDIA PROJECTS FOCUSING ON ACCESSIBILITY

Education

The National Center to Improve Practice (NCIP) is a collaborative project between the Education Development Center (EDC) and WGBH Educational Foundation in Boston. Funding is through the U.S. Department of Education, Office of Special Education Programs, 1992 to 1997. The focus is on promoting change within local schools and districts so that practitioners will effectively use technology, media, and materials to improve outcomes for students with disabilities (NCIP 1995).

The Western Pennsylvania School for the Deaf (1997), in collaboration with Carnegie Science Center and Duquesne University, received a grant for provision of interactive multimedia in their classrooms. Teachers were trained in integrating technological tools for visual literacy into the curriculum. The creation of an Interactive Technology Lab and the success of shared teacher-student responsibility has proved to be crucial (http://www.wpsd.edu).

Distance education initiatives through Gallaudet University include "Telling Tales in ASL: From Literature to Literacy" (April 1997), a live interactive video teleconference on ASL storytelling presented in American Sign Language with spoken English and open captions, and now available on videocassette (Gallaudet 1997, Silver 1997).

Quite a number of interactive videoconferencing and distance education efforts have occurred in the past two or so years, with initiatives currently under way at various schools and postsecondary programs, including Gallaudet University, National Technical Institute for the Deaf at the Rochester Institute of Technology, California School for the Deaf at Riverside,

Eastern North Carolina School for the Deaf, Maryland School for the Deaf, New Jersey School for the Deaf, Model Secondary School for the Deaf at Gallaudet, and others (King 1977).

General

The Universal Telecommunications Access Project is funded through the National Institute on Disability and Rehabilitation Research, U.S. Department of Education, 1995 to 1999. It is a collaborative endeavor involving the World Institute on Disability, Trace Research and Development Center, and Gallaudet University. Components include systems engineering studies, telecommunications access research, universal design specification and review, standards efforts, applications of technology for independence, and knowledge dissemination and utilization (Gallaudet University 1997).

Internet

Many people and organizations are actively working on Web access. These projects fall into two categories: (1) access guidelines (e.g., W3C's Web Access Initiative, http://www.w3.org/WAI; Trace Center's Guidelines for Web Access, http://trace.wisc.edu/text/guidelns) and (2) building accessible Web pages (e.g., Educational Testing Service–Hansen, Katz, and Forer 1997) in which essential information can be accessed aurally or through text.

The Web Access Project is funded through the Telecommunications Funding Partnership for People with Disabilities and the Boston Foundation, continuing through 1997. Focus is on researching, developing, and testing methods for integrating access technologies, such as captioning and audio description, and new Web tools into a World Wide Web site, making it fully accessible to blind or deaf Internet users (NCAM 1997c).

The Research and Development Institute's "Project Vision—Visually Impaired Students and Internet Opportunities Now" involves a training program developed for teaching blind and

visually impaired students how to access the Internet using assistive technology (Kapperman, Heinze, Hahn, and Dalton 1997). Researchers on this two-year project, funded by the Office of Special Education Programs of the U.S. Department of Education, conducted a demonstration project in which they trained teachers and then field-tested methods on five low-vision and four blind children. The children enjoyed being in the pilot project, and having access to information on the Internet had a positive impact on them.

Kiosks

The Tactile Talking Display System (nicknamed "the Talking Kiosk") was a collaborative project of the Computer Center for Visually Impaired People at Baruch College, the American Foundation for the Blind, and the Stein Partnership, an architectural firm.

The Talking Kiosk is a public kiosk at New York's Pennsylvania Station that can be used by people who are blind or visually impaired. The kiosk uses voice and enlarged screen text for output, and a talking/tactile map and touch-tone telephone keypad for input. The kiosk provides information that travelers need to use this large and complex transit facility. In addition to information about where tracks and ticket booths are, the kiosk provides information about retail facilities and other transit services in the station.

The Trace Center has developed an accessible public kiosk at Minneapolis's Mall of America, the largest shopping mall complex in the United States. This kiosk provides information in various formats so that it is accessible to people with hearing, visual, and physical disabilities as well as to those with reading problems or those who cannot read at all. People with visual impairments can use the "Quick Read Button," which reads aloud portions of the kiosk's screen. There is also a "Touch and Confirm" mode, in which a voice tells you what you're pointing to on the screen. A simple touch of a button activates this mode. For those who are hard of hearing, there is a volume control and a handset that is compatible with hearing aids. Deaf people can use

the "Show Sounds Captions" button, through which information is presented visually on screen, including closed captioning (Vanderheiden 1997).

Software

Accessible Interactive Media: Digital Captioning Tools and a Model Interactive Captioned Media Product is a grant project funded through Small Business Innovation Research, U.S. Department of Education, 1996 to 1998. Phase II focus is on development of tools for captioning multimedia CD-ROMs and Internet applications (CAP-Media 1996).

The Center for Applied Special Technology (CAST), has worked on two CD-ROMS that have access built in for blind and visually impaired people.

CAST has worked with Scholastic, Inc., a top manufacturer of children's books and software, to develop Wiggle Works, a CD-ROM aimed at children from kindergarten to second grade. The CD holds a total of 72 children's books with which the user can interact. Each story can be read aloud using a digitized voice, and font size and colors can be changed to suit the individual. In addition, like the Annenberg CD (mentioned below), it includes a scanning feature with talking buttons, so that a blind person can hear what options are available and choose one by pressing a key.

Wiggle Works appears to be the most accessible CD-ROM currently available for blind and visually impaired people, but lacks certain features that would make it fully accessible—notably, accessibility features to help a visually impaired person install and begin the program, and built-in video descriptions of the book's rich pictures, which are an integral part of the story. However, the "message button" feature allows someone to record a short description of each picture, which can be addressed later by pushing a computer key.

CAST has also produced "Communications Technology for Everyone: Implications for the Classroom and Beyond," an accessible CD-ROM of a report of the same name from the Annenberg Washington Program (1994). The CD-ROM, like Wiggle Works, includes scanning with talking buttons. Other features include a large-text version, associated ASCII text files, and the capability of having the text read aloud. It does not include audio description of photos or video.

CAST's "Ultimate Kid Books," aimed at children from preschool to second grade, is a publishing system that also reads books aloud. It has the added feature of allowing someone to type in picture descriptions that can then be read aloud.

The Corporation for Public Broadcasting/WGBH National Center for Accessible Media (NCAM) is working on a CD-ROM project funded by the National Science Foundation. It is developing techniques and guidelines for making science CD-ROMs accessible to blind and visually impaired children and will be developing a prototype CD-ROM with accessibility built in. All text will be readable using a screen reader or the speech will be built in, and all graphical elements will be described in text or read aloud.

APPENDIX G

MISSION OF THE NATIONAL COUNCIL ON DISABILITY

Overview and Purpose

The National Council on Disability (NCD) is an independent federal agency led by 15 members appointed by the President of the United States and confirmed by the U.S. Senate.

The overall purpose of NCD is to promote policies, programs, practices, and procedures that guarantee equal opportunity for all individuals with disabilities, regardless of the nature or severity of the disability; and to empower individuals with disabilities to achieve economic self-sufficiency, independent living, and inclusion and integration into all aspects of society.

Specific Duties

The current statutory mandate of NCD includes the following:

- Reviewing and evaluating, on a continuing basis, policies, programs, practices, and procedures concerning individuals with disabilities conducted or assisted by federal departments and agencies, including programs established or assisted under the Rehabilitation Act of 1973, as amended, or under the Developmental Disabilities Assistance and Bill of Rights Act; as well as all statutes and regulations pertaining to federal programs that assist such individuals with disabilities, in order to assess the effectiveness of such policies, programs, practices, procedures, statutes, and regulations in meeting the needs of individuals with disabilities.

- Reviewing and evaluating, on a continuing basis, new and emerging disability policy issues affecting individuals with disabilities at the federal, state, and local levels, and in the private sector, including the need for and coordination of adult services, access to personal assistance services, school reform efforts and the impact of such efforts on individuals with disabilities, access to health care, and policies that operate as disincentives for individuals to seek and retain employment.

- Making recommendations to the President, the Congress, the Secretary of Education, the Director of the National Institute on Disability and Rehabilitation Research, and other officials of federal agencies, respecting ways to better promote equal opportunity, economic self-sufficiency, independent living, and inclusion and integration into all aspects of society for Americans with disabilities.

- Providing the Congress, on a continuing basis, advice, recommendations, legislative proposals, and any additional information that the Council or the Congress deems appropriate.

- Gathering information about the implementation, effectiveness, and impact of the Americans with Disabilities Act of 1990 (42 U.S.C. 12101 et seq.).

- Advising the President, the Congress, the Commissioner of the Rehabilitation Services Administration, the Assistant Secretary for Special Education and Rehabilitative Services within the Department of Education, and the Director of the National Institute on Disability and Rehabilitation Research on the development of the programs to be carried out under the Rehabilitation Act of 1973, as amended.

- Providing advice to the Commissioner with respect to the policies and conduct of the Rehabilitation Services Administration.

- Making recommendations to the Director of the National Institute on Disability and Rehabilitation Research on ways to improve research, service, administration, and the collection, dissemination, and implementation of research findings affecting persons with disabilities.

- Providing advice regarding priorities for the activities of the Interagency Disability Coordinating Council and reviewing the recommendations of this Council for legislative and administrative changes to ensure that such recommendations are consistent with the purposes of the Council to promote the full integration, independence, and productivity of individuals with disabilities.

- Preparing and submitting to the President and the Congress an annual report titled *National Disability Policy: A Progress Report.*

- Preparing and submitting to the Congress and the President an annual report containing a summary of the activities and accomplishments of the Council.

International

In 1995, NCD was designated by the Department of State to be the official contact point with the U.S. government for disability issues. Specifically, NCD interacts with the special rapporteur of United Nations Commission for Social Development on disability matters.

Consumers Served and Current Activities

While many government agencies deal with issues and programs affecting people with disabilities, NCD is the only federal agency charged with addressing, analyzing, and making recommendations on issues of public policy that affect people with disabilities regardless of age, disability type, perceived employment potential, economic need, specific functional ability, status

as a veteran, or other individual circumstance. NCD recognizes its unique opportunity to facilitate independent living, community integration, and employment opportunities for people with disabilities by ensuring an informed and coordinated approach to addressing the concerns of persons with disabilities and eliminating barriers to their active participation in community and family life.

NCD plays a major role in developing disability policy in America. In fact, it was NCD that originally proposed what eventually became ADA. NCD's present list of key issues includes improving personal assistance services, promoting health care reform, including students with disabilities in high-quality programs in typical neighborhood schools, promoting equal employment and community housing opportunities, monitoring the implementation of ADA, improving assistive technology, and ensuring that persons with disabilities who are members of minority groups fully participate in society.

Statutory History

NCD was initially established in 1978 as an advisory board within the Department of Education (Public Law 95–602). The Rehabilitation Act Amendments of 1984 (Public Law 98–221) transformed NCD into an independent agency.

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GLOSSARY

Analog captioning: Subtitles in video materials, configured for analog transmissions.

Closed captioning: Subtitles embedded in video materials and visible only to those who have a caption decoder, which is usually built into television sets.

Digital captioning: Subtitles embedded in video materials, configured for digital transmissions.

Digital video disc (DVD): A new media storage format intended to replace audio CDS, CD-ROMs, videotapes, and laser discs. DVD players will fall into two categories: (1) stand-alone devices attached to televisions and (2) DVD-ROM drives in computers (similar to today's CD-ROM, but with eight times the storage capacity). Originally scheduled for release in June 1996, DVD players were delayed because of copyright negotiations between the entertainment and computer industries.

Open captioning: Subtitles that are visible to anyone viewing the video material (broadcast, cable, videocassette, and otherwise).

Remote captioning: Captioning services provided through remote means, usually through telephone lines. May require use of on-site interpreters to supply audio.

Screen reader: Device that enables blind and visually impaired people to use a computer as a sighted person would, either by magnifying the text on the screen or by converting the text to speech or braille.

Telecommunications relay service (TRS): Provides a link between voice and text telecommunications users.

Teletypewriter (TTY): A device that enables individuals to communicate in print across telephone wires.

Video description (also known as audio description): A means of making television, movies, and other video programming accessible through verbal (audio) descriptions of key visual elements inserted into natural pauses in the program's dialogue, without interfering with the sounds and dialogue that are a regular part of the program.

Video relay interpreting: Provides a visual link between voice and text telecommunications relay service users, incorporating usage of sign-to-voice and/or voice-to-sign and related relay interpreting skills.

Video remote interpreting: Provision of sign-to-voice and/or voice-to-sign and related types of interpreting services using video technology through remote telephone connections, thereby bypassing the need for on-site interpreters.

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92

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